

cavity, said joined pipe lengths having a plurality of continuous juxtapositioned reinforcement fibers formed with a solid material composition selected from the group consisting of ceramics, metals, carbon, glass compositions and organic polymers thermally bonded to the outer wall surface of said joined pipe lengths at a predetermined spatial angle with respect thereto for maximum effectiveness in withstanding applied internal stress when the reinforced pipe lengths are subsequently put into service, the continuous fibers having been continuously applied in an unbonded while maintaining the joined pipe lengths in their hollow condition and the subsequent thermal bonding of the applied fibers only adhering the applied fibers to the outer wall surface of the underlying pipe lengths without utilizing further adherence agents and while not further melting said underlying pipe length to avoid introducing thermally induced residual stress therein.

Cancel claim 10

REMARKS

All remaining claims 1-3 and 5-9 being examined in the subject application have been still further amended to hopefully comply with the Examiner's requirement expressed in the outstanding Final Rejection. In said regard, the Examiner requires the present Applicant "to present evidence from which the Examiner could reasonably conclude that the claimed product differs in kind from those of the prior art." It is respectfully submitted that the now proposed as well as previously entered amendments made in the remaining claims clearly differentiates the claimed product from that either disclosed or obviously suggested in the sole Gibson et al reference being relied upon for reasons given below.

The previously entered amendments made in the remaining claims include recitation of a "hollow" thermoplastic pipe member or multiple pipe members being wrapped in a solid physical state with reinforcement fibers in "an unbonded condition" and which are thereafter thermally bonded to the "outer wall surface" of the underlying solid pipe member(s). In so doing, said pipe member(s) is required (as originally claimed) to be continuously moved "in the same linear direction" while the reinforcement fibers are continuously wrapped about the outer pipe surface. Understandably, such manner of forming the claimed product

requires the moving pipe member(s) to be maintained in a solid condition during the fiber application which was also pointed out to the Examiner in the immediately preceding amendment submitted by the present applicant. While apparently not having sufficiently convinced the Examiner in said previous amendment that Gibson et al's method of forming such final product results in a structurally dissimilar article, it still remain evident that such structural dissimilarity exists in several critical other respects.

First of all, the requirement in Gibson et al to heat the underlying pipe to a "molten state" produces thermally induced residual stress in the final article which is a serious impediment far less encountered in the now claimed improvement. Gibson et al further requires heating of the reinforcement fibers when applied which imparts still further thermally induced residual stress in the final article due to thermal expansion differences existing between said applied fibers and the underlying thermoplastic pipe as the final article cools. Such residual stress buildup in Gibson et al's final article detrimentally reduces the mechanical strength of the reinforced pipe member while not being readily discernible to visual inspection by any end user. Accordingly, cracks in the Gibson et al's final article can be more frequently encountered during subsequent use as can physical separation more readily occur between the "embedded" fibers and the pipe member.

Secondly, the thermal expansion mismatch in the final Gibson et al article between the combined reinforcement fibers and the single thermoplastic pipe member being reinforced in said manner raises a still further problem. More particularly, it has long been recognized that reheating of a residually stressed thermoplastic member above its glass transition temperature can relieve such stress in the member. In doing so with the Gibson et al reinforced pipe member, however, the thermal expansion mismatch between fiber and the underlying pipe becomes very likely to produce a physical separation therebetween during the reheating. Such destruction of the entire composite member is largely averted in the now claimed product by reason of a dissimilar method of fiber reinforcement being employed. In the present improvement, the entire outer surface of the pipe member(s) being reinforced is uniformly heated with external heating

means surrounding said outer pipe surface. This manner of heating the outer surface produces a uniform stress distribution throughout the entire member with the fiber reinforced final product exhibiting more dimensional stability as well as greater mechanical strength. As distinct therefrom, Gibson et al employs heating of the fibers when being applied which creates a localized stress condition in the composite article due to the above noted thermal expansion mismatch as the locally heated area cools. In further requiring the entire underlying pipe member to be maintained in a "molten state" for proper fiber embedment, Gibson et al also risks far greater thermal degradation of said polymer material than experienced with the now claimed improvement. By selectively heating only the outer surface of said pipe member(s) in accordance with the now claimed improvement, the polymer material being heated is exposed to such degradation for a far lesser time period.

The now claimed product exhibits a still further structural improvement over the Gibson et al final article. Specifically, the present thermoplastic pipe member which remains solid when heated "only" on the outer surface (as recited in the now amended claims) to secure previously applied reinforcement fibers thereto undergoes a beneficial thermal expansion during said heating step. The thermally expanded pipe member presses against the already applied fibers thereby applying a compaction pressure causing the externally applied fiber to uniformly distribute the load across the pipe structure. Fibers that may have more load apply more pressure as they melt into the molten outer surface of the underlying pipe member and thus tend to equalize a load carrying capacity with more lightly loaded fibers that do not melt into the outer pipe surface as deeply. The end result is a more improved physical structure requiring less reinforcement fibers to provide the same mechanical strength than required in the Gibson et al final product.

The presently claimed product differs structurally in other critical respects from the final product disclosed or obviously suggested in Gibson et al. The thermoplastic member being fiber reinforced in Gibson et al is said to require a thermoplastic material selection which is both "melt-processable" and "shear sensitive" (see column 2, lines 9-10 in said reference) while further stating that a PEEK polymer

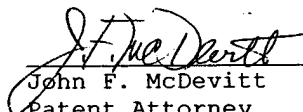
would not be a suitable thermoplastic material (see column 2, lines 59-62 in said reference). The now claimed final product employs an already prefabricated thermoplastic polymer for the underlying pipe member(s) which is particularly designed for this end-use application as well as not being available as a fiber material due to limitations in current fiber manufacturing procedures. Accordingly, the now claimed final product can employ prefabricated thermoplastic pipe members having mechanical fittings already adhered thereto, such as end fittings and the like, which Gibson et al's fabrication does not enable. Gibson et al's method of fabrication understandably further limits the length of a pipe member being reinforced. As distinct therefrom, continuous pipe lengths can now be reinforced as presently claimed. The underlying molten thermoplastic material in Gibson et al is also required to undergo "sufficient shear" action when the reinforcement fibers are being applied (see column 2, lines 22-27 in said reference). Such required shearing action is caused with both external heating and external pressure being exerted upon the reinforcement fibers when applied. The underlying pipe member(s) remain solid when reinforcement fibers are applied in the present improvement hence the now claimed final article is not subjected to any such required treatment. Having the final articles fabricated in such dissimilar manner causes still other structural differences in the respective products. A use of commingled fibers in Gibson et al limits the applied fiber angle to approximately 15 degrees from the longitudinal axis of the underlying pipe member. Fiber angles in the now claimed reinforced pipe member(s) can include a 0 degree angle with respect to the longitudinal pipe axis. Likewise, the now claimed final article can employ reinforcement fiber devoid of any matrix polymer, such as strapping tape, which is not seen as obviously suggested for use in said reference.

It can only be reasonably concluded from the above specified structural differences existing in the now claimed article from the final article either disclosed or obviously suggested in Gibson et al that sufficient factual evidence has been presented to rebut any prima facie question of obviousness found therebetween. It can only be unpermitted hindsight in view of the present applicant's teachings that can be regarded to obviously suggest the now claimed invention

from a reference employing a dissimilar fabrication method employing entire dissimilar means to produce dissimilar results. One skilled in the reinforcement of thermoplastic pipe members would not obviously consider from reading this reference that having the reinforcement fiber merely bonded to the outer surface of an already prefabricated solid pipe member in a far more simplified manner could produce an unexpectedly superior final product. The limitation expressed in Gibson et al with respect to selection of starting materials as well as process conditions needed to produce the above demonstrated inferior product disclosed therein simply do not obviously suggest the now claimed invention. It is respectfully urged, therefore, that the outstanding final rejection be withdrawn and that all now amended remaining claims 1-3 and 5-9 be allowed as structurally distinguishing over the structural features which do not exist in the Gibson et al final article.

An Appendix of the present claim amendments is also provided on a separate page accompanying this Amendment. Finally, entry of the presently revised remaining claims is respectfully requested for appeal purposes.

Respectfully submitted,

  
John F. McDevitt  
Patent Attorney  
Reg. No. 19,140

2255 Par Lane #626  
Willoughby Hills, OH 44094  
440/585-0919  
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CERTIFICATE OF MAILING

I HEREBY CERTIFY that this Amendment Under 37 CFR 1.116(a) is being deposited with the Postal Service in an envelope addressed to: Assistant Commissioner for Patents, Washington, D.C. 20231 on this 16<sup>th</sup> day of September 2002.

  
John F. McDevitt

APPENDIX

1. (Twice Amended) A fiber reinforced pipe length comprising a solid thermoplastic organic member having an outer wall enclosing an inner hollow cavity which includes a plurality of continuous juxtapositioned reinforcement fibers formed with a solid material composition selected from the group consisting of ceramics, metals, carbon, glass compositions and organic polymers thermally bonded to the outer wall surface at a predetermined spatial angle with respect thereto for maximum effectiveness in withstanding the applied internal stress when the reinforced pipe length is subsequently put into service, the continuous fibers having been continuously applied in an unbonded condition while maintaining said pipe length in its hollow condition and the subsequent thermal bonding of the applied fibers [primarily] only adhering the applied fibers to the outer wall surface of the underlying pipe length without utilizing further adherence agents[.] and while not further melting said underlying pipe length to avoid introducing thermally induced residual stress therein .

7. (Twice Amended) A plurality of identical fiber[s] reinforced pipe lengths joined together prior to reinforcement at the ends and each comprising a solid thermoplastic organic polymer member having an outer wall enclosing an inner hollow cavity, said joined pipe lengths having a plurality of continuous juxtapositioned reinforcement fibers formed with a solid material composition selected from the group consisting of ceramics, metals, carbon, glass compositions and organic polymers thermally bonded to the outer wall surface of said joined pipe lengths at a predetermined spatial angle with respect thereto for maximum effectiveness in withstanding applied internal stress when the reinforced pipe lengths are subsequently put into service, the continuous fibers having been continuously applied in an unbonded condition while maintaining the joined pipe lengths in their hollow condition and the subsequent thermal bonding of the applied fibers [primarily] only adhering the applied fibers to the outer wall surface of the underlying pipe lengths without utilizing further adherence agents[.] and while not further melting said underlying pipe length to avoid introducing thermally induced residual stress therein.